CLAIMS

1.   A method for controlling disposition of a candidate object, said method comprising:

        determining a first value indicative of a number of references to said
            candidate object that are not references from other objects; and

5   controlling disposition of said object on the basis of said first value.

2.   The method of claim 1, wherein determining a first value comprises reading an
        external-reference count.

3.   The method of claim 1, wherein controlling disposition of said candidate object on
        the basis of said first value comprises:

10   determining, on the basis of said first value, whether there exists at least
                one reference to said candidate object that is not from another object;
                and

            marking said candidate object for preservation if there exists at least one
                reference to said candidate object that is not from another object.

15   4.   The method of claim 1, wherein controlling disposition of said candidate object on
        the basis of said first value further comprises:

            determining a second value indicative of a number of references to said
                candidate object from other objects; and

            determining a third value indicative of a number of cyclic paths including
20   said candidate object; and

            controlling disposition of said candidate object on the basis of said second
                value and said third value.

5.   The method of claim 4, wherein determining a second value comprises reading an
        internal-reference count.

25   6.   The method of claim 4, wherein determining a third value comprises:

identifying a referred object that lies on a path containing a reference originating at said candidate object;

determining a fourth value indicative of a number of references to said referred object that originate at other objects, said fourth value being associated with said referred object; and

determining a fifth value indicative of the number of cyclic paths to said candidate object that pass through said referred object, said fifth value being associated with said referred object.

7. The method of claim **6**, wherein determining a third value further comprises:

initializing a sixth value associated with said referred object, said sixth value being indicative of a number of cyclic paths known to include said candidate object and said referred object; and

adjusting said sixth value if said referred object has a reference directly to said candidate object.

8. The method of claim **7**, wherein determining a third value further comprises:

identifying a referring object having a reference to said referred object; and

detecting a defined relationship between said fifth value and said sixth value associated with said referred object,

adjusting a seventh value associated with said referring object in response to detection of said defined relationship, said seventh value being indicative of a number of known cyclic paths that include said candidate object and said referring object.

9. The method of claim **8**, wherein detecting a defined relationship between said fifth value and said sixth value comprises determining that said fifth value and said sixth value are equal to each other.

10. The method of claim **8**, wherein adjusting a seventh value comprises adjusting said

seventh value by an amount corresponding to said sixth value.

11. The method of claim 4, wherein controlling disposition of said candidate object on the basis of said second value and said third value comprises:

determining if said candidate object is externally unreachable or externally reachable;

designating said candidate object for destruction if said candidate object is externally unreachable; and

designating said candidate object for preservation if said candidate object is externally reachable.

12. The method of claim 4, wherein:

determining a third value comprises:

classifying a path to said candidate object as originating at an external reference or not originating at an external reference; and

controlling disposition of said candidate object comprises

designating said candidate object for destruction if no path to said candidate object originates at an external reference.

13. The method of claim 12, wherein classifying a path comprises:

for each object on said path, determining if said object has an external reference; and

classifying said path on the basis of whether at least one object on said path has a reference selected from the group consisting of an external reference and an internal reference from an object not reachable from said candidate object.

14. The method of claim 1, wherein controlling disposition of said candidate object on the basis of said first value comprises:

determining whether said candidate object is referenced from outside of a tree; and

marking said candidate object for preservation if there exists a reference to said candidate object from a tree.

15.   A method for automatic control of disposition of a candidate object in an object-oriented programming environment, said method comprising:

detecting deletion of a reference to a candidate object;

determining a number of cyclic paths that include said candidate object;

determining a number of internal references to said candidate object;

controlling disposition of said object on the basis of a defined relationship between said number of internal references and said number of cyclic paths.

16.   A computer-readable-medium having encoded thereon software for causing a computer to control disposition of a candidate object, said software comprising instructions for causing a computer to:

determine a first value indicative of a number of references to said candidate object that are not references from other objects; and

control disposition of said object on the basis of said first value.

17.   The computer-readable medium of claim 16, wherein said instructions for determining a first value comprise instructions for causing said computer to read an external-reference count.

18.   The computer-readable medium of claim 16, wherein said instructions for controlling disposition of said candidate object on the basis of said first value comprise instructions for causing a computer to:

determine, on the basis of said first value, whether there exists at least one

reference to said candidate object that is not from another object; and

mark said candidate object for preservation if there exists at least one reference to said candidate object that is not from another object.

19.   The computer-readable medium of claim **16**, wherein said instructions for causing a computer to control disposition of said candidate object on the basis of said first value further comprise instructions for causing said computer to:

determine a second value indicative of a number of references to said candidate object from other objects; and

determine a third value indicative of a number of cyclic paths including said candidate object; and

control disposition of said candidate object on the basis of said second value and said third value.

20.   The computer-readable medium of claim **19**, wherein said instructions for causing said computer to determine a second value comprise instructions for causing said computer to read an internal-reference count.

21.   The computer-readable medium of claim **19**, wherein said instructions for causing said computer to determine a third value comprise instructions for causing said computer to:

identify a referred object that lies on a path containing a reference originating at said candidate object;

determine a fourth value indicative of a number of references to said referred object that originate at other objects, said fourth value being associated with said referred object; and

determine a fifth value indicative of the number of cyclic paths to said candidate object that pass through said referred object, said fifth value being associated with said referred object.

22. The computer-readable medium of claim **21**, wherein said instructions for causing said computer to determine a third value further comprise instructions for causing said computer to:

> initialize a sixth value associated with said referred object, said sixth value being indicative of a number of cyclic paths known to include said candidate object and said referred object; and

> adjust said sixth value if said referred object has a reference directly to said candidate object.

23. The computer-readable medium of claim **22**, wherein said instructions for causing said computer to determine a third value further comprise instructions for causing said computer to:

> identify a referring object having a reference to said referred object; and

> detect a defined relationship between said fifth value and said sixth value associated with said referred object,

> adjust a seventh value associated with said referring object in response to detection of said defined relationship, said seventh value being indicative of a number of known cyclic paths that include said candidate object and said referring object.

24. The computer-readable medium of claim **23**, wherein said instructions for causing said computer to detect a defined relationship between said fifth value and said sixth value comprise instructions for causing said computer to determine that said fifth value and said sixth value are equal to each other.

25. The computer-readable medium of claim **23**, wherein said instructions for causing said computer to adjust a seventh value comprise instructions for causing said computer to adjust said seventh value by an amount corresponding to said sixth value.

26. The computer-readable medium of claim **19**, wherein said instructions for causing

said computer to control disposition of said candidate object on the basis of said second value and said third value comprise instructions for causing said computer to:

> determine if said candidate object is externally unreachable or externally reachable;

> designate said candidate object for destruction if said candidate object is externally unreachable; and to

> designate said candidate object for preservation if said candidate object is externally reachable.

27. The computer-readable medium of claim **19**, wherein:

> said instructions for causing said computer to determine a third value comprise instructions for causing said computer to:

>> classify a path to said candidate object as originating at an external reference or not originating at an external reference; and

> said instructions for causing said computer to control disposition of said candidate object comprise instructions for causing said computer to

>> designate said candidate object for destruction if no path to said candidate object originates at an external reference.

28. The computer-readable medium of claim **27**, wherein said instructions for causing said computer to classify a path comprise instructions for causing said computer to:

> for each object on said path, determine if said object has an external reference; and

> classify said path on the basis of whether at least one object on said path has reference selected from the group consisting of an external reference and an internal reference not reachable from said candidate object.

29. The computer-readable medium of claim **16**, wherein said instructions for causing said computer to control disposition of said candidate object on the basis of said first value comprise instructions for causing said computer to:

> determine whether said candidate object is referenced from outside of a tree; and

> mark said candidate object for preservation of there exists a reference to said candidate object from a tree.

30. A computer-readable medium having encoded thereon software for causing a computer to automatically control disposition of a candidate object in an object-oriented programming environment, said software comprising instructions for causing said computer to:

> detect deletion of a reference to a candidate object;

> determine a number of cyclic paths that include said candidate object;

> determine a number of internal references to said candidate object;

> controlling disposition of said object on the basis of a defined relationship between said number of internal references and said number of cyclic paths.

31. A method of transferring software from a source computer-system to a target computer-system, said method comprising:

> transferring, to said target computer-system, instructions for causing said target computer-system to

>> determine a first value indicative of a number of references to said candidate object that are not references from other objects; and to

>> control disposition of said object on the basis of said first value.

32. The method of claim **31**, wherein transferring instructions for causing said computer

-29-

system to determine a first value comprises transferring instructions for causing said computer system to read an external-reference count.

33. The method of claim **31**, wherein controlling disposition of said candidate object on the basis of said first value comprises:

5   determining, on the basis of said first value, whether there exists at least one reference to said candidate object that is not from another object; and

         marking said candidate object for preservation if there exists at least one reference to said candidate object that is not from another object.

10   34. The method of claim **31**, wherein transferring instructions for causing said computer system to control disposition of said candidate object on the basis of said first value further comprises transferring instructions for causing said computer system to:

         determine a second value indicative of a number of references to said candidate object from other objects; and

15   determine a third value indicative of a number of cyclic paths including said candidate object; and

         control disposition of said candidate object on the basis of said second value and said third value.

35. The method of claim **34**, wherein transferring instructions for causing said computer
20   system to determine a second value comprises transferring instructions for causing said computer system to read an internal-reference count.

36. The method of claim **34**, wherein transferring instructions for causing said computer system to determine a third value comprises transferring instructions for causing said computer system to:

25   identify a referred object that lies on a path containing a reference originating at said candidate object;

determine a fourth value indicative of a number of references to said

referred object that originate at other objects, said fourth value being

associated with said referred object; and

determine a fifth value indicative of the number of cyclic paths to said

5   candidate object that pass through said referred object, said fifth value

being associated with said referred object.

37.   The method of claim **36**, wherein transferring instructions for causing said computer

system to determine a third value further comprises transferring instructions for

causing said computer system to:

10   initialize a sixth value associated with said referred object, said sixth value

being indicative of a number of cyclic paths known to include said

candidate object and said referred object; and

adjust said sixth value if said referred object has a reference directly to said

candidate object.

15   **38.**   The method of claim **37**, wherein transferring instructions for causing said computer

system to determine a third value further comprises transferring instructions for

causing said computer system to:

identify a referring object having a reference to said referred object; and

detect a defined relationship between said fifth value and said sixth value

20   associated with said referred object,

adjust a seventh value associated with said referring object in response to

detection of said defined relationship, said seventh value being

indicative of a number of known cyclic paths that include said candidate

object and said referring object.

25   **39.**   The method of claim **38**, wherein transferring instructions for causing said computer

system to detect a defined relationship between said fifth value and said sixth value

comprises transferring instructions for causing said computer system to determine

that said fifth value and said sixth value are equal to each other.

40. The method of claim **38**, wherein transferring instructions for causing said computer system to adjust a seventh value comprises transferring instructions for causing said computer system to adjust said seventh value by an amount corresponding to said

5 sixth value.

41. The method of claim **34**, wherein transferring instructions for causing said computer system to control disposition of said candidate object on the basis of said second value and said third value comprises transferring instructions for causing said computer system to:

10 determine if said candidate object is externally unreachable or externally reachable;

designate said candidate object for destruction if said candidate object is externally unreachable; and

designate said candidate object for preservation if said candidate object is

15 externally reachable.

42. The method of claim **34**, wherein:

transferring instructions for causing said computer system to determine a third value comprises transferring instructions for causing said computer system to:

20 classify a path to said candidate object as originating at an external reference or not originating at an external reference; and

transferring instructions for causing said computer system to control disposition of said candidate object comprises transferring instructions for causing said computer system to

25 designate said candidate object for destruction if no path to said candidate object originates at an external reference.

43. The method of claim **42**, wherein transferring instructions for causing said computer system to classify a path comprises transferring instructions for causing said computer system to:

for each object on said path, determine if said object has an external

5   reference; and

classify said path on the basis of whether at least one object on said path has reference selected from the group consisting of an external reference and an internal reference not reachable from said candidate object.

44. The method of claim **31**, wherein transferring instructions for causing said computer

10   system to control disposition of said candidate object on the basis of said first value comprises transferring instructions for causing said computer system to:

determine whether said candidate object is referenced from outside of a tree; and

mark said candidate object for preservation of there exists a reference to

15   said candidate object from a tree.

45. A method of transferring software from a source computer-system to a target computer-system, said method comprising:

transferring, to said target computer-system, instructions for causing said target computer-system to

20   detect deletion of a reference to a candidate object;

determine a number of cyclic paths that include said candidate object;

determine a number of internal references to said candidate object;

control disposition of said object on the basis of a defined relationship between said number of internal references and said number of

25   cyclic paths.